

tion cup (or “vacuum cup”) in combination with a needle injection device, according to an embodiment of the present disclosure;

[0012] FIG. 2A is a perspective view of the vacuum cup illustrated in FIG. 1, showing a vacuum chamber of the cup and an array of electrodes located within the chamber, according to an embodiment of the present disclosure;

[0013] FIG. 2B is a bottom plan view of the vacuum cup illustrated in FIG. 2A, showing a pattern in which the electrodes are arrayed;

[0014] FIG. 2C is a plan elevation view of one of the electrodes illustrated in FIGS. 2A-2B;

[0015] FIG. 2D is a sectional side view of the vacuum cup illustrated in FIG. 2A, taken along a central axis of the cup;

[0016] FIG. 2E is an enlarged sectional view of region 2E-2E illustrated in FIG. 2D;

[0017] FIG. 2F is an enlarged sectional view of region 2F-2F illustrated in FIG. 2D;

[0018] FIG. 3A is a perspective view of a sleeve that carries the electrodes and is insertable within the vacuum chamber illustrated in FIG. 2A;

[0019] FIG. 3B is a bottom plan view of the sleeve illustrated in FIG. 3A;

[0020] FIGS. 3C-3D, 3E-3F, 3G-3H, 3I-3J, and 3L-3M are respective bottom plan and sectional side views of sleeves having alternative electrode array patterns, according to additional embodiments of the present disclosure;

[0021] FIGS. 4A-4E are sectional side views of the vacuum cup illustrated in FIG. 2A adjacent tissue, showing representative stages of employing the vacuum cup in a vacuum-assisted electroporation treatment;

[0022] FIG. 4F is a sectional side view of the vacuum cup illustrated in FIG. 2A, showing various extents to which the vacuum cup can draw tissue into the vacuum chamber;

[0023] FIG. 5A is a perspective view of a vacuum cup having flexible electrodes, according to an embodiment of the present disclosure;

[0024] FIG. 5B is a sectional side view of the vacuum cup illustrated in FIG. 5A, taken along a central axis of the cup;

[0025] FIG. 5C is an enlarged sectional view of region 5C-5C illustrated in FIG. 5B, showing the electrodes in a neutral state;

[0026] FIG. 5D is an enlarged sectional view of region 5D-5D illustrated in FIG. 5B, showing the electrodes in a flexed state;

[0027] FIGS. 6A and 6B are respective perspective and side elevation views of an electrode having a contact surface that defines protrusions, according to an embodiment of the present disclosure;

[0028] FIGS. 6C and 6D are respective perspective and side elevation views of an electrode having a contact surface that defines laterally-elongate protrusions, according to another embodiment of the present disclosure;

[0029] FIG. 7A is a perspective view of a vacuum cup having a triangular distal opening and vacuum chamber geometry, according to an embodiment of the present disclosure;

[0030] FIG. 7B is a bottom plan view of the vacuum cup illustrated in FIG. 7A;

[0031] FIG. 7C is a sectional perspective view of the vacuum cup illustrated in FIG. 7A, taken along a central axis of the cup;

[0032] FIG. 7D is an elevation plan view of an electrode array positioned within the vacuum cup illustrated in FIG. 7A;

[0033] FIG. 7E is a side view of the electrode array illustrated in FIG. 7D;

[0034] FIG. 8A is a perspective view of a vacuum cup having a rectangular distal opening and vacuum chamber geometry, according to an embodiment of the present disclosure;

[0035] FIG. 8B is a bottom plan view of the vacuum cup illustrated in FIG. 8A;

[0036] FIG. 8C is a sectional perspective view of the vacuum cup illustrated in FIG. 8A, taken along a central axis of the cup;

[0037] FIG. 9A is a sectional side view of an electroporation assembly that includes a vacuum cup having a receptacle in which a needle-free injection device is received, according to an embodiment of the present disclosure;

[0038] FIG. 9B is an enlarged sectional side view showing a representative stage of employing the electroporation assembly illustrated in FIG. 9A to inject an agent into tissue drawn into the vacuum chamber;

[0039] FIG. 10A is a sectional perspective view of another embodiment of a vacuum cup having a receptacle in which a needle-free injection device is received, wherein the vacuum cup has a cup housing that defines a manifold including a plurality of ports in fluid communication with the vacuum chamber through a corresponding plurality of apertures defined in the electrodes;

[0040] FIG. 10B is an enlarged perspective, partial sectional view of the corresponding ports and apertures shown illustrated in FIG. 10A;

[0041] FIG. 10C is a perspective, partial sectional view of an alternative arrangement of corresponding ports and apertures, according to another embodiment of the present disclosure;

[0042] FIG. 10D is an enlarged sectional side view of a portion of the vacuum cup illustrated in FIG. 10A during use to provide an electroporation treatment to adipose tissue;

[0043] FIG. 11A is a visual representation of methylene blue distribution in subcutaneous pig tissue without application of vacuum pressure (left) and with application of vacuum pressure (right) via a vacuum cup configured similarly to the cup illustrated in FIG. 2A;

[0044] FIGS. 11B and 11C show a side-by-side comparison of fluid distribution in guinea pig adipose tissue after injection of methylene blue; the injection in FIG. 11B was performed with a needle-free vacuum cup similar to that shown in FIG. 9A; the injection in FIG. 11C was performed with a subcutaneous needle technique;

[0045] FIG. 12 is a graph showing 12-week humoral immunogenicity ELISA data in guinea pigs after electroporation treatments in adipose tissue with pGX 123 (a DNA vaccine against influenza virus nucleoprotein (NP)), particularly showing comparative humoral immune responses following electroporation treatment with: the vacuum cup illustrated in FIG. 2A; and a caliper-electrode electroporation device;

[0046] FIG. 13 is a graph showing 8-week humoral immunogenicity ELISA data in guinea pigs after treatments of pGX 2303 (a DNA vaccine against human respiratory syncytial virus fusion glycoprotein (RSV-F)), particularly showing comparative humoral immune responses following: electroporation treatment of adipose tissue with the vacuum